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ROYAL ENTOMOLOGICAL SOCIETY
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ANNUAL MEETING

WEDNESDAY, 19TH JANUARY, 1944, **at 3.30 p.m.**

AGENDA

1. Confirmation of the Proceedings of the General Meetings held on 12th November and 1st December, 1943.
2. Recommendations of candidates for Fellowship.
3. Announcement of election of new Fellows.
4. Announcement of election of Officers and Council for 1944.
5. The following additions have been made to the Library since the meeting on 1st December, 1943.

Presented.

Ford, E. B.: *The study of heredity.* London, 1938. [The author.]

Ford, E. B.: *Mendelism and Evolution.* 3rd edition, London, 1940. [The author.]

Moulton, F. R. (Editor): Aerobiology. *Publ. Amer. Ass. Adv. Sci.* **17**, 1942.

Campbell, F. L., and Moulton, F. R. (Editors): Laboratory procedures in studies of the Chemical Control of Insects. *Publ. Amer. Ass. Adv. Sci.* **20**, 1943.

Woodhouse, L. G. O., and Henry, G. M. R.: *The Butterfly fauna of Ceylon.* Colombo, 1942. [Mr. L. G. O. Woodhouse.]

Swammerdam, J.: *Bybel der Natuure. Biblja Naturae, sive Historia insectorum . . . lingua Batava . . . conscripta: accedit praefatio in qua Vitam auctoris descripsit Hermannus Boerhaave. Latinam versionem adscripsit Hieronimus David Gaubius.* Vol. 2. Leydae, 1837–38. [Mr. R. L. E. Ford.]

Borkhausen, M. B.: *Naturgeschichte der europäischen Schmetterlinge.* Theil 1–5. Frankfurt, 1788–94. [Mr. B. C. S. Warren.]

Koleopterologische Rundschau, Wien. Bd. 7 (1918)–Bd. 16 (1930). [Wanting Bd. 8, Nos. 4–6.] [Dr. P. J. L. Roche.]

Purchased.

Latter, O. H. : *Bees and Wasps.* Cambridge, 1913.

Byerley, I. : *The Fauna of Liverpool.* London, 1854.

Hampson, G. H. : A collection of papers on PYRALIDAE, 1895–99.

In addition, separates have been presented by Mr. E. P. Wiltshire, the United States Department of Agriculture, the American Entomological Society, Mr. R. E. Snodgrass, Fleet-Paymaster T. Bainbrigge Fletcher, R.N., Dr. W. J. Hall, the Rev. E. J. Pearce, and the Imperial Institute of Entomology.

6. Council's Report.
7. Treasurer's Report and Balance Sheet.
8. The President's Remarks.
9. Vote of thanks to the Officers.

On behalf of the Hope Department of the University Museum, Oxford, Prof. G. D. Hale Carpenter has kindly undertaken to arrange an exhibit in the Library illustrating the work of the late Sir Edward Poulton, F.R.S., Honorary Life President of the Society from 1934.

Tea will be served in the Library after the meeting.

PROCEEDINGS OF THE GENERAL MEETING HELD ON 12TH NOVEMBER, 1943.

Dr. E. A. COCKAYNE, President, in the Chair.

Present, 52 Fellows and 28 Visitors.

The meeting was devoted exclusively to a discussion, jointly with the members of the British Ecological Society, on :—

The interrelations of Plants and Insects ; the place of both in the Eco-system.

In opening the discussion Professor E. J. SALISBURY, F.R.S., made the following remarks :—

The beneficial relations of insects to plants are mainly those of pollinating agents or, less directly, parasites or predators on insect pests.

The rôle of insects as pollinating agents has been very extensively explored but in large part from the aspect of the pollinating mechanism and the remarkable adaptation that often obtains between flower and insect. The high degree of such specialisation, which led Wallace to predict correctly the existence of a Sphingid moth with a proboscis matching in length the twelve-inch spur of the Madagascan orchid *Angraecum sesquipedale*, is no less remarkable than the elaborate character of the pollinating mechanisms themselves. But these have been studied for the most part, under the stimulus of the theory of natural selection, as examples of adaptation and, despite the vast array of information, we still know all too little respecting many aspects of fundamental knowledge.

Muller, Knuth and others have contributed much as to the relevant floral structures and the insect visitants. In recent years von Frisch has added appreciably to our knowledge of the behaviour of bees, but as yet we know far too little as to the preferential visiting of species flowering simultaneously. To what extent does excessive flowering in self-sterile fruit trees, such as we have witnessed during the past season, lead to deficient cross-pollination because the pollinating insects find more than sufficient occupation for their acquisitive instincts on a single tree ?

Again, to what extent is it true that early flowering in the spring, with its manifest disadvantages, is offset by the increased chances of insect visitors owing to lack of competition ? A Persian Willow in my garden at Radlett, *Salix medemii*, which flowers in late February or early March, when weather conditions are favourable, is swarming with bees but whether this be due to lack of competition or the attractive hyacinth-like scent of the flowers I frankly do not know. Yet the practical importance of knowledge as to the extent and character of the competitive relations between flowers cannot be gainsaid.

Another question of great economic importance into which the competitive factor enters is the distance apart at which cross-pollinating species must be grown in order to avoid the risks of hybridisation. Interesting results in this field are being obtained with Brassicas by Mr. Crane at Merton, but the question clearly has its bearing on natural hybridisation, as well as on commercial seed production and the maintenance of pure stocks of seed.

The elaborate and familiar relation between the moth *Pronuba* and *Yucca filamentosa* in which the reproduction of each is dependent on the other, but the larvae take a high percentage of potential ovule production, serves to illustrate how narrow may be the margin between benefit and disadvantage in the relations between insects and plants.

If we turn to the relations of insects to plants as pests or predators we find there are many questions here too that require answers. Why for instance is it that some insects are almost omnivorous whereas others are confined to particular species? Our familiarity with human preference and dislikes is apt to blind us to the recognition that there are here fundamental problems to be investigated. Something of the complexity of the problem is appreciated from the fact that whilst the larvae of some insects are in the wild state found on one food-plant only they can be reared in captivity on a variety of species. An analysis of the physiological basis for such preferences might well yield data of great practical importance in the field of horticulture and agriculture.

Again, we may ask how do insects recognise their source of food? The wasp that lays its egg in the hidden caterpillar that has tunnelled its way beneath the bark of the tree may recognise the larval presence by movements the sound of which is beyond the range of human hearing, but the carrot fly that lays its egg in the seedling carrot before its emergence above the soil is scarcely likely to hear the plumule shouldering its way through the soil to the surface and more probably is dependent on a sublimated sense of smell. It has, I believe, been estimated that some Lepidoptera are 1500 times more sensitive to nectar than we are. The use of repellents and attractants has opened up a new means of plant protection but much more fundamental work is required in the realm of sense physiology if we are to use such devices to the best advantage.

The control of insect pests has become one of the important factors in successful agriculture and the large-scale operations of modern crop production facilitate the building up of a high insect population. This has resulted in the recognition of the fact that crop rotation affords an important check to population increase. I have recently suggested that the comparative freedom of certain wild species of plants which are not infrequently met with in large numbers may be associated with their intermittent occurrence. Such for instance are the Foxgloves and Mulleins of coppiced areas or the assemblages of *Chenopodium rubrum* and *Polygonum nodosum* that we associate with areas of exposed mud. The high populations of Ragwort which occur year after year in the Breckland area and on some of our dunes are, however, decimated by the larvae of the Cinnabar moth and the decrease of this plant usually follows excessive abundance of the predators.

Dr. Cunliffe of Oxford has succeeded in breeding a strain of oats that is in considerable degree immune from the attacks of the Frit fly, as well as being in other respects desirable, but wherein this comparative immunity rests still remains to be ascertained.

The relation of insect to plant is complicated where, as in the Aphides, the same species may occur on two different hosts at different phases of the life history. But, we may ask, why is it that one species requires two different hosts and another allied species only one? If the winter host be the more primitive association this does not explain for us the apparent survival value of restrictions that might appear to be a weakness rather than an asset.

The rôle of insects as vectors of plant diseases has long been known in respect to the transfer of the sweet conidia of the Ergot of Rye from the infected inflorescence to the ovaries of other flowers but this aspect of the insect-plant relation has gained in scientific interest and practical importance since the discovery of the rôle of sucking insects as transmitters of virus diseases or of beetles in the transmission of Elm Disease. The recognition that there is a reaction between insect and virus manifests itself in the distinction between the persistent and non-persistent types.

So far we have considered, though in barest outline, some of the diversities that may be exhibited by the insect in its relations to the plant, but there is also the fascinating problem presented by the plant reactions to the insect. Thus not only do we find different gall insects producing some sixty different types of gall on the same species of oak, but the two generations of the same species of gall insect producing on the same host-plant such diverse types of gall as the Spangle Gall and Currant Gall of the oak, both of which may sometimes be seen side by side on the same leaf. By contrast we may recall that the Oak-apple Gall produced upon the shoots are similar in character to the galls produced by the alternate agamic generation upon the roots of the oak.

In so far as it concerns insects which feed upon plants, the insect-plant relation can be regarded phylogenetically as one in which natural selection will tend to ensure the survival of those strains of a species which evade insect attack. Thus for many such relations a particular phase in the life history of the insect must coincide with a particular phase in the development of the plant. The attacks of *Tortrix viridana* sometimes devastate *Quercus robur* and sometimes *Quercus sessiliflora* and I have seen a row of trees of *Q. robur* which included a single individual that was always belated and escaped attack whereas all the other trees were completely defoliated. Prof. Munro informs me that this is correlated with the relation between oviposition and the precise stage of bud development.

The British flora may be said to present species ranging in all degrees from those which have perhaps persisted from preglacial times, through early post-glacial introductions to those which are known to have come into these islands during historic times. Thus the term " native " has no exact significance for our flora, the creation of which was not an event but a process, and though it is often convenient to use the term native, it is important to apprehend that this merely implies a distinction between those species known or suspected to have been introduced and those concerning the period of arrival of which we are ignorant. Put in this form we see the distinction to be one which scientifically is comparatively unimportant. What is, however, of great biological importance is whether the species can or cannot compete with other species in the absence of human interference. In other terms, whether its persistence is conditioned by natural or artificial factors, in which the plant-insect relation plays an important part.

But though we are not justified in attempting to draw an arbitrary distinction between organisms that have arrived during the period of exact recording and those of earlier introduction, that is far from implying that the length of sojourn in these islands is without significance. It is, for example, a matter of great biological interest whether a plant species in these islands supports the same insect population as the same kind of plant on the Continent of Europe. The nature and variety of the insect predators and pests to which a plant species in Britain is subject may be an important indication as to the length of time that the plant has been present in these islands or, on the other hand, as to the efficiency of insect dispersal.

The influence of man has created in the past, and is constantly creating in the present, habitat conditions where the pressure of competition is reduced or even negligible and the species associated with the arrested successions thus artificially maintained have been frequently regarded as under suspicion of being introductions. But the species which to-day we find most frequently occurring in, or even confined to, artificial conditions may be those which in former times were to be met with in similar though much less frequent conditions created by natural agencies. On the other hand, they may represent what may be termed domestic species which have arisen since the widespread occurrence of such habitats and which in some instances may have extended into natural habitats of a similar character. This might appear to have little concern with the relations between plants and insects were it not that both groups of organisms present the same general problem and an intensive study from this point of view of such intensely interesting series as that presented by the group of house spiders and their allies might well shed light on the fundamental problem. The domesticated flora and fauna not only deserve more attention than they have hitherto received but attention to the relations of both might well reveal what the study of either alone could not achieve.

The following speakers continued the discussion :—

Dr. E. A. Cockayne :

Species of Macrolepidoptera limited by special plant species.

Specialisation appears to be greater in some other Orders than in the Lepidoptera, and in the Microlepidoptera than in the Macrolepidoptera. Many of the latter are attached to a genus rather than to a species, and others eat two or three plants belonging to allied genera, such as *Verbascum* and *Scrophularia*, *Betula* and *Alnus*, or *Fraxinus* and *Ligustrum*. Of the last pair most species that eat one eat the other as well, but I believe that *Deuteronomos fuscantaria* always feeds on *Fraxinus* and *Nothopteryx polycommata* on *Ligustrum*. Oak has more species of Macrolepidoptera attached to it than any other plant in Britain; they are 18 in number, and belong to several families. But the pedunculated and sessile oaks are now considered to be separate species, and both are eaten indiscriminately. The larvae feeding on oak must therefore be classed with those feeding on a genus and not on one species of a genus. In the case of many larvae limited to a single species, it is the only representative of the genus found in this country, but on the continent, where other members occur, these also are eaten; for example *Bupalus piniaria* is confined to *Pinus sylvestris* in Britain, but eats other species of *Pinus* on the continent. *Phragmites communis*, the sole representative of the genus in the greater part of Europe, has more species confined to it than any other native plant. They are nine in number, *Leucania obsoleta*, *Meliana flammea*, *Nonagria geminipuncta*, *N. neurica*, *N. dissoluta*, *Arenostola brevilinea*, *A. phragmitidis*, *Hydroecia lutosa*, and *Macrogaster arundinis*, and the majority feed internally. All their imagines match the dead reeds in colour, and most are highly specialised. *Chilodes maritima* is only found in reed beds, but probably eats insects as well as the lining of dead reeds.

There are cases in which a larva eats only one species of a genus, although there are other native representatives. For instance, *Cucullia absynthii* is confined to *Artemisia absynthium*, *Discoloxia blomeri* to *Ulmus montana*, *Euchloris smaragdaria* and *Eupithecia extensaria* to *Artemisia maritima*, and *Collix sparsata* to *Lysimachia vulgaris*. In such cases the selection of only one species is due as a rule to ecological conditions. *Euchloris smaragdaria* and *E. extensaria* are very particular; the former prefers *Artemisia* growing on sea-walls on the Essex and Kent saltings, while *E. extensaria* is almost always found on the tall plants growing on the inland side of the salt marshes nearest to the cultivated land and never on those nearest to the sea. I have seldom seen serious damage done by any of the larvae confined to one species or genus. The association between plant and insect must be a very ancient one and a balance has been arrived at. Indeed moths of the genus *Dianthoecia* fertilise the species of *Silene* or *Lychnis*, on the seeds of which their larvae feed, and so do good as well as harm to them. In my experience it is the polyphagous species which, under natural conditions, are liable to become pests.

It is interesting that most of our moths with a very restricted range are not restricted by the absence of a special food-plant. *Anepia* (*Dianthoecia*) *irregularis*, however, has the same narrow range on the Breck sand as its food-plant *Silene otites*, and it is probable that the limited south-western range of *Drepana harpagula* is coterminous with that of *Tilia parvifolia*. The reasons for such limitation are very varied. In some cases they are due to comparatively recent entry into the country, in others they are clearly ecological or climatic, but often the cause must be a very subtle one. Every case should be considered separately and some would require prolonged and detailed study.

There are some interesting examples of larvae, particular in their diet, feeding on quite unrelated food-plants. For example *Xanthia gilvago* and *X. ocellaris* both eat wych elm and poplar, the former preferring wych elm and the latter poplar, and *Vanessa polychloros* eats elm and sallow. The larvae of *Cucullia verbasci*, which usually eats *Verbascum* or *Scrophularia*, is not infrequently found on *Buddleia*. It is probable that such plants possess some chemical substance in common. This is undoubtedly the case with *Sinapis* and *Tropaeolum*, both of which are eaten by the larvae of *Pieris brassicae* and *P. rapae*. Another fact which supports this was communicated to me by the late H. Worsley-Wood. He succeeded in feeding his larvae of *Xanthia ocellaris* on dock leaves smeared with the juice of crushed poplar and brought them to maturity. Absence of some essential chemical may explain why sometimes closely allied species are rejected. Being unable to obtain leaves of *Serratula tinctoria*, on which to feed my larvae of *Acosmetia caliginosa*, I gave them leaves of various species of *Serratula* growing in the Chelsea Physic Garden. Some they ate readily and others they consistently refused to touch at all stages of their life. When I mentioned this to the Curator, he said that botanists had divided the genus into two sections and that my larvae had eaten all those species in the section to which *S. tinctoria* belonged. I suggest that some chemical compound was absent in those belonging to the other section.

Some of our Lepidoptera have reached the northern or western extremity of their distribution and have become limited to special ecological conditions or to a special food-plant. *Papilio machaon* is found only in the Fens and feeds chiefly on *Peucedanum palustre*, while abroad it is found in all kinds of country and feeds on many Umbellifers; *Malacosoma castrensis*, an inland and woodland species on the continent, is only found in the saltmarshes of south-eastern England, though it feeds on most of the plants which grow there. *Brachionycha nubeculosa*, which feeds on many kinds of tree abroad, eats only *Betula alba* in its local haunts in the Highlands of Scotland.

There are instances of biological races with different food-plants. *Eupithecia denotata* eats the seeds of *Campanula trachelium*, and its race *E. jasioneata* eats those of *Jasione montana*, while *Hydrelia flammeolaria* eats maple in the south and alder and mountain ash in Scotland. The distribution of the two plants might explain the former case, though it is not clear why other species of *Campanula* are avoided, but there is no obvious reason for the different food-plants of the *Hydrelia* in the south and in the north. *Plemyria bicolorata* eats rose, blackthorn, crab apple, birch, and alder in England, but in my experience it eats alder only in the north of Scotland.

Captain C. Diver :

Insects limited by the general conditions imposed by plant communities.

I feel considerable hesitancy in saying much on the subject which falls to me in this discussion, because our real knowledge of it is so limited and patchy that it is almost impossible to appreciate the extent of the gaps. This is partly because of the inherent difficulties of the problem but mainly because so few workers have tried to attack the subject on anything like a sufficiently extensive scale. The good field naturalist undoubtedly knows where and when to look for the species in which he is interested. Conversely, when he sees a particular habitat, he knows, almost at a glance, whether any of these species are likely to be living there; and, if he is that rare person a really good naturalist, he is nearly always right. But one gets the impression that this recognition is almost intuitive. Beyond a few outstanding essentials—that the necessary food-plants are present, that there is rotten wood in the right condition, that the place is sufficiently open and sunny or the reverse, that his animals like sand-dunes, or whatever it may be—it is seldom that he can really analyse out all the characteristics which, when in combination, he subconsciously recognises as creating the right habitat. In fact, this apparently intuitive recognition is the subconscious crystallisation of innumerable small impressions and experiences revealed by his acute powers of observation and slowly built up by his memory into a complete picture. The tragedy is that so much of this invaluable knowledge often dies with him.

Knowledge of this kind is, in my view, fundamental to a clear understanding of some of the major problems of biology, whether pure or applied. No progress can be made in the study of animal and plant populations, distribution, colonisation, plagues, the control of pests, and so on, until we can give a proper answer to the question why this place is " right " and that place is " wrong ".

My object in this paper is to attempt no more than to ask a few questions and to give a few illustrations from British species of the simpler aspects of this problem.

Even in a well-known group like the butterflies, a group in which at least the main larval food-plants can be stated with reasonable certainty, there are many problems yet to be resolved.

Lycaena corydon Poda [1] is commonly known as the Chalk-hill Blue. Why is this species particularly addicted to chalk hills? Meyrick gives its food-plants as *Hippocrepis*, *Lotus* and *Anthylis*. *Lotus corniculatus* Linn., which judging from the habits of *L. corydon* is presumably the plant meant, is a widely tolerant species living in many places besides chalk downs. But there seems some doubt about *L. corydon*'s habits. Newman and Leeds, in their *Text-book of British Moths and Butterflies* (1913), give *Hippocrepis* as the only food-plant. If that is true, it might be the reason why this butterfly prefers chalk hills, since *Hippocrepis* is a calcicole plant. But *L. corydon* is a local species, even on chalk hills. Do we expect to find it wherever there is a reasonable population of *Hippocrepis*? If not, what are the other limiting factors? Is it even certain that this food-plant is a primary limiting factor? May it not be that the primary factors are to be found among the general conditions on downs and that the presence of *Hippocrepis* is only a secondary consideration in the sense that it provides the most satisfactory diet among the relatively few plant species open to choice in the places where the butterfly likes to live?

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[1] The names used here for Lepidoptera and their food-plants are, for general convenience of reference, those given by Meyrick, E., *A Revised Handbook of British Lepidoptera*, 1927.

The Marbled White, *Melanargia galathea* Linn., and the Ringlet, *Epinephele hyperanthus* Linn., both feed on grasses, including *Dactylis glomerata* Linn., the Cocksfoot grass. *Dactylis* is a common grass with a wide range of tolerance. Both butterflies are more or less local, and we should surely be surprised to find their larvae feeding together on the same population of *Dactylis*. The Marbled White generally likes dry sunny places (with a partiality for chalk downs), while the Ringlet likes damp shady ones. Is it known why this limited tolerance is displayed?

The converse condition may be illustrated by the two Skippers, *Hesperia malvae* Linn. and *H. tages* Linn. which feed on different plants, but often live together. The larva of *H. malvae* is stated to feed on species of *Rubus*, *Potentilla* and *Fragaria*, and that of *H. tages* on *Lotus*. But the plant species eaten have a far wider range of tolerance than the two butterflies. Again it must be asked, can the real limiting requirements be stated? If the answers to questions like these are not known, is it not time that a serious effort was made to find them?

No one, of course, doubts that the problem embraces far more than the mere distribution of a particular food-plant; and in " general feeders " this may be of quite minor importance in delimiting the actual spots occupied. There are the necessities and predilections of each and every stage to be considered—the egg, the young, the pupa if there is one, and the adult insect. And it is not only temperature, light, moisture and food that must be considered; but the provision of cover, wind-breaks, sunning and resting sites, mating facilities and the chance to exercise special powers, such as hovering for hovering's sake as in SYRPHIDAE. In short, it is not enough that a habitat should contain the bare necessities of life; it must also be congenial.

All these attributes are affected by variations, not only in the species composition or species frequency of the plant carpet, but in what may be called its general structure. As a generalisation it can be said that a particular insect species will only live in those habitats (or those associations of minor habitats in reasonably close geographical grouping) which can provide the degree of variety required without going outside the range which can be tolerated for *any* specific component. And, moreover, allowing for reasonable adaptability on the part of the insect, the right conditions have to be present at approximately the right time of year—that is, at the right stage of development.

To take a simple example, there is a marked seasonal change in the conditions at ground level in a habitat where bracken grows out of a low sward of mixed plants. In such places during the spring and early summer there is practically no tall vegetation and, consequently, no shade above the level of the fallen dead fronds; whereas later on, when the bracken fronds expand, the place is crowded with tall stems of fairly even height (an important characteristic) and is heavily shaded. If a species is to live in a place like this throughout the year, it must be able to stand these changes, otherwise it can only occupy the site, if at all, for that part of the year during which its particular requirements are met.

Obviously, the habitat range of a species, by which is meant the number of different kinds of habitat it can occupy and not its geographical distribution or spread, must be limited to those habitats which *all* contain a whole series of common factors which are expressed within given limits of variation and never regularly transgress those limits. If this condition were not fulfilled, the sites would not be permanently occupiable, though they might support temporary populations.

The application to species of terms like " common " and " rare " is apt to be misleading. The important fact is that some species are much more " choosey " than others, though within their narrow limits they may develop quite large populations. Two Phycitid moths, when considered in relation to their food-plants, provide a nice illustration of this. *Myelois neophanes* Durr. is a local moth, but one which seems to appear (within its limited geographical range) wherever its peculiar requirements are properly fulfilled. The larva apparently feeds on the globular black fungus, *Daldinia concentrica* (Bolf.) Ces. & de Not., which develops a good population on the burnt stems of such plants as gorse and birch—a rather precarious requirement. In contrast to this, the larva of the scarce *Nephopteryx similella* Zinck. feeds on the symbolical British tree, the oak. Although this latter species is a great prize to collectors of microlepidoptera, not many more than a dozen specimens appear to have been secured, and these mainly from one spot in the New Forest. The rest of its distribution is given as Central Europe. But why, in this country, does it live only in one or two particular patches of oaks, and sparsely at that? Is it that here it is only just within its margin of tolerance, and that in the other oakwoods something important is missing or something intolerable (possibly a potential parasite) is present? Compare this with the abundant and pestilential *Tortrix viridana* Linn., which is also, at least primarily, an oak feeder.

Another group of the Lepidoptera, the grass moths of the genus *Crambus*, can be used to illustrate further aspects of the general problem. According to Meyrick, out of the 29 British species included in this genus, 13 feed on or at the roots of grasses, 2 live under moss, 1 (*C. paludellus* Hübn.) possibly feeds on *Typha*, and for the remaining 13 the larval habits are not stated. Sixteen of these species, including two which for lack of sufficient data must be omitted from further consideration, occur on South Haven Peninsula (Studland Heath, Dorset), and here the habitats of their adult populations have been subjected to a detailed analysis. If the habitats occupied by the remaining fourteen species are classified according to the presence or absence of heather, it is found that, of the nine species known to be grass feeders, seven are confined to grass communities where Ericoids are absent—though grasses often form an important component of many Ericoid communities—while two tolerate the presence of heather. The remaining five species, all of which are heather-tolerant, fall into the group of which the larval habits appear as yet to be unknown; but information is accumulating about the range of habitats in which at least the adults like to live. Three of these, *C. pascuellus* Linn., *C. sylvellus* Hübn. and *C. uliginosellus* Zell., together with one of the known grass-feeders, *C. perlellus* Scop., may all occur in the same locus, and do so on one sloping bog at Studland which covers an area of not more than about three acres. But when this bog is divided into its real mosaic of habitats, as determined by a minute survey of the changes in the plant carpet, this loose observation that all four live together is at once seen to be inaccurate. *C. sylvellus* and *C. uliginosellus* not only prefer, but are practically confined to much wetter conditions than are normally tolerated by the other two, which tend to be limited to the damp heath fringing the bog proper.

In the genus *Crambus* the resting populations of adults are often found in sharply defined patches which, where the larval habits are known, would seem to coincide with the areas probably occupied by the larval populations. In so far as this proves to be true, it becomes simpler to state the total range of conditions required by each species throughout its life-cycle. But it is instructive to turn to a group where this condition is not fulfilled. Two genera of hover-flies will serve as an illustration—*Helophilus* and *Eristalis*.

It is fortunate that there occur at Studland seven out of the nine British *Helophilus* and ten out of the eleven *Eristalis*. The larvae of both these genera can broadly be stated to live in stagnant wet conditions; but the adults require additional amenities which are not all present in the places where the larvae can live; and if these are not represented in neighbouring habitats, places where the larvae could live are not likely to be occupied by permanent populations.

In my experience, the adult *Helophilus* generally stays closer to the larval habitat than does the adult *Eristalis*; but it requires the structure of the vegetation to be such that this provides sheltered flying places and preferably a fair supply of flowers to visit. *Helophilus* will not normally be found hovering or laying in the type of marsh where the vegetation over a large area is uniformly short, which means that there is no shelter from wind at heights above a few inches from ground level—a condition exemplified, for instance, by the sloping bog referred to above. What these flies seem to like is an uneven structure giving a good mosaic of patches of short and tall vegetation, the air above the former being protected by the wind-breaks made by the latter. It does not appear to be so important which plant species are present as that some should be tall and some short; although a good flowering population of *Potentilla palustris* Scop. is an added attraction for the less adventurous species, provided it is growing in a sunny and reasonably sheltered spot.

The species of *Eristalis* vary more widely in their needs; though most species are inveterate flower visitors, and the commoner ones are on the wing from the flowering of the sallow to the flowering of the ivy. But they need also the right conditions for hovering. *E. aeneus* Scop. and *E. sepulchralis* Linn. can tolerate the low vegetation and exposed conditions of salt-marshes, where they hover close to the ground. *E. intricarius* Linn. tends to hover high, but does not apparently demand good wind-breaks. While *E. pertinax* Scop. and *E. tenax* Linn., which usually hover at heights between 4 and 8 feet, seem to find their optimum for this exercise in sheltered woodland glades. The primary characteristic of a woodland glade for this purpose is precisely the same as that required by *Helophilus* in the marsh; that is, an area of relatively low vegetation surrounded and sheltered by taller species. But unless these glades are of sufficient size relative to the height of the trees so as to get full sunlight, they will not provide good conditions for these species. *Eristalis* seldom hovers in the dapple light under trees. These sites are occupied by other Syrphids—particularly the common *Syrphus ribesii* Linn. and *S. vitripennis* Meig.

Similar considerations affect the distribution of Dragonflies. The adults require the right conditions, not only for hawking, but for their ranging flights. Some like expanses of water unbroken by emergent plants. Others seem to prefer it where isolated stems of, say, *Eleocharis* or depauperate *Phragmites* occasionally break the surface and provide intermittent resting perches.

Others, again, seek "cliffs" of vegetation such as tall hedgerows, or the woodland glade type of structure; the latter is particularly favoured, for instance, by *Cordulia aenea* Linn.

A patchwork of tall and short vegetation is also important in providing optimum conditions in the grassy habitats occupied by grasshoppers. Here the clumps of taller plants not only act as windbreaks, but provide resting cover not available in the surrounding short turf over which the animals move for feeding and other activities. The presence of this kind of characteristic is vital to many small ground-living species. If one examines what it is like at ground level under a continuous population of knee-high *Calluna*, one realises that in many respects it is the same as dense woodland—gloomy, still and dank- and only the few animals that can tolerate these depressing conditions will live there. But as soon as one passes to discontinuous *Calluna* where there are open, sunny patches of lower plants, the number of animal species present rises immediately. A change of this type, for instance, if the other conditions are right, at once allows colonisation by ants, such as *Tetramorium caespitum* Linn. and *Acanthomyops alienus* Först. None of the species I have studied in this group will tolerate deep shade, whether it is provided by tall *Calluna* or by trees.

The width, the complexity and the difficulties of the general problems raised by these few illustrations need no stressing; there is here an immense and fascinating field for careful observation and research. As a final plea, I would seriously urge that, though it is highly important to call a species by its right name according to the rules, it is even more important to know where and how that species lives, and why it chooses to live where it does.

Dr. C. F. C. Beeson :

The influence of insects on the regeneration, composition and destruction of forests.

Destruction. In the virgin climatic climax-forest it seems that no components of its insect fauna will separately or together cause its destruction under normal conditions. Fluctuations in insect-populations are less intense in climax communities than in sub-climax communities; freedom from insect epidemics is characteristic of primeval forest. During the lifetime of a tree in a tropical forest there may be three or four thousand generations of an insect feeding on it. Indeed, a more or less balanced state is essential for the tree's existence. But should this balance be upset by any catastrophe initially due to external factors, then the forces of destruction latent in phytophagous insects are released, and the primitive life-community may collapse. Catastrophic factors which cause initial mortality are, *e.g.*, storm, flood, drought, fire, sharp climatic changes, new insect-borne diseases, etc.

Typical insects able to destroy primitive forests are borers of the bark or sap wood of dead and moribund trees (Scolytidae, Cerambycidae). They multiply in the abnormal accumulation of dead food-material and their overwhelming numbers enable them to attack and kill the living healthy trees, thus spreading the effect of the original catastrophe far beyond its focal point.

Such outbreaks are comparable with those caused over wide areas of pine forest in N. America by Scolytidae, or of coniferous forests in Europe by Scolytidae and Cerambycidae, or of dipterocarp forests in Indo-Malaya by Cerambycidae; here, of course, the communities are semi-natural and subseral. In more degenerate and in definitely artificial forests, destruction by defoliators (Lepidoptera, Coleoptera, TENTHREDINIDAE) is a more characteristic feature everywhere. But if defoliators are instrumental in the final disappearance of virgin forest they act in a secondary rôle to borers.

The rôle of sapsuckers is complicated by their connection with virus diseases. It seems unlikely that natural processes can successfully re-adjust a tree-community to the introduction of a fatal virus disease, *e.g.*, the spike of sandal carried by an Indian Jassid.

Regeneration. Among seed-destroying insects there are two common groups: (1) species with short life-cycles but with emergence-periods and adult longevity prolonged to the second year (BRUCHIDAE, CURCULIONIDAE, SCOLYTIDAE, PYRALIDAE), and (2) species with short life-cycles and short emergence-periods with alternative generations in the seedling root and shoot or the shoot of older saplings (PYRALIDAE, EUCOSMIDAE, and other micros). Life-histories of these types should ensure that mature adults are always available at the next fruiting-season no matter if the insect is monophagous or polyphagous. Theoretically, the destruction of seeds should be total in all seed-years, good or bad, but it is not so. Even in an extreme case such as the Agromyzid fly attacking the flowers and fruits of *Lantana* in its extensive thickets in the tropics, local elimination of the plant does not result, although there are 20–25 generations of the fly per annum. Again, when bamboos flower periodically over vast areas in the Far East, the seeds are destroyed by incredible numbers of pentatomid bugs, nevertheless regeneration of bamboo normally follows.

I suggest the chief effect of seed insects is to regulate the initial density of stocking by a dominant plant-species.

Distribution. Insects feeding on young saplings also regulate the colonisation of a suitable habitat, but by more indirect means. A few examples will illustrate this interaction: (*a*) When meliaceous trees like *Cedrela* (toon), or *Swietenia* (mahogany) regenerate in open unshaded sites, the two- or three-year-old plant is cut back by pyralid shoot-borers and makes no progress for several years; if it starts life under moderate overhead or lateral shade it escapes injury by borers. This regulation by light intensity and borer holds good in Australia, the Far East and the West Indies. (*b*) Pure forests of the leguminous *Dalbergia sissoo* support a noctuid defoliator which has 10–13 generations a year in India. The tree is prevented from extending its range into regions of low rainfall and low subsoil water-level because on such sites it comes into leaf late; the first flush is at once defoliated and subsequent flushes are destroyed by later generations of the pest. (*c*) Where teak attempts to invade sites occupied by the verbenaceous shrub, *Clerodendron*, the young teak saplings are attacked by a cerambycid derived from *Clerodendron*. The same holds good for *Gmelina arborea* (also Verbenaceae), but this tree's power of recovery is greater than that of teak.

Composition. The composition of a forest type may be largely determined at the period of its regeneration, but further modification by insect agency may take place at later stages of its life-cycle. Interaction of this sort occurs in the forests of balsam fir, spruce and pine in north-east America where the spruce budworm (TORTRICIDAE) is the agent. On balsam fir the budworm obtains the best conditions for the development of the hibernated first instar larva, which is the critical stage; on black spruce and white spruce, conditions are less favourable; on red spruce they are better; jack pine supports a biological race of the budworm. Mixed forests of balsam fir and spruce, with or without pine, form a community that is stable and is free from destructive epidemics. Where there is tendency for pure stands of balsam fir to predominate or where the biotic balance of the natural mixture has been upset by selective exploitation, fatal epidemics of budworm develop on the fir and spread to otherwise non-susceptible types. The composition of the second-growth mixed forests shows that the budworm is a factor in natural succession.

Mixed versus Pure. This example leads on to the general question of mixed versus pure forest and insect attack. It is an axiom of forestry that pure forests (and especially even-aged stands) are more liable to epidemics than are mixed forests. Nevertheless, there are plenty of natural consociations dominated by one species of tree that are immune, *e.g.*, redwood in North America, *Eucalyptus* in Australia, bamboo in the Malayan Region, deodar in India.

What is a pure forest? Take the case of deodar. If the undergrowth and soil covering are destroyed by unrestricted grazing, conditions are created for the multiplication of an endemic geometrid defoliator, which can wipe out its parent deodar forest despite intrinsic immunity. Similar conditions obtain in evergreen oak forests with Lasiocampid defoliators. Here, evidently, the pure forest is only monospecific in a silvicultural sense; it is ecologically a consociation and the insect fauna of soil and shrub strata protects the dominant tree-community.

What constitutes a mixed forest from the aspect of plant protection? Natural protection is achieved by a multiplicity of converging processes, many of which are latent or even superfluous until an emergency energises them. The chief factors are: (1) the physical structure of the forest which determines the amount of space occupied by the food of the pest and the amount which obstructs the discovery of that food; (2) the floristic composition of the forest which comprises three categories of plants—desirable, undesirable and neutral species.

Desirable species are (*a*) those supporting insects that are the alternative hosts of the parasites and diseases of the pests of the main crop; and (*b*) those supporting insects that are part of the varied diet of polyphagous predacious insects that feed also on the pests; and (*c*) those providing suitable shelter, nesting and breeding facilities for the vertebrate and arthropod predators.

Undesirable species are alternative food-plants of pests feeding on the trees of the main crop.

Neutral species are those which are quite neutral by all tests of biological control; they are undesirable when they occupy space that could be put to better purpose, economic or biotic.

Given exact data of this kind on the plant-associates of a timber species and its pests, one can formulate a mixture which will afford the maximum protection to the crop under all variations in the climatic and edaphic environment. Something on these lines has been done for the Hyblaeid and Pyralid defoliators of teak.

Finally, to complete the picture, one must assess the influence of the scavengers and decomposers of dead tissues of plants and animals, particularly in the soil and field strata, about which we have very incomplete information.

Useful work has been done on the disintegration of heart-wood by borers (Coleoptera and termites) and on the associated enzymes, yeasts and fungi. Beetles appear to be much more specific in their relationships than are termites. Cellulose and lignin-dissolving fungi thrive independently of termites in wood in forests but termites do not occur in wood unless in direct and continuous relations with fungi.

As regards soil formation and fertilisation it is largely guesswork. Dung beetles are picturesquely described as " the vast manurial army of the tropics, the natural fertilising agents of the soil and the prime factor saving the world from slow corruption." One author estimates that Coprinae bury 200,000 tons of excrement every day in India; and that is typical of our ideas on this group.

Termites are described by an authority (Wheeler) as important agents in assisting the growth and renewal of the great rain forests of the Amazon, the Congo and the East Indies, while even in the dry savannas of South America and the open forests of Australia they hasten the dissolution of all vegetation. Yet when the Council of the Imperial Agricultural Bureaux recently circularised the British Commonwealth of Nations for information on this point, the combined experience of empire biologists had very little to offer.

In the subsequent discussion Dr. H. Godwin (*President of the British Ecological Society*), after thanking the Royal Entomological Society on behalf of his Society for providing an opportunity for joint discussion and for their kind hospitality, called attention to the fact that the British Ecological Society had just begun publication of a *Biological Flora of the British Isles*. This had originally been conceived by Professor Salisbury and, for each species considered, the most intensive co-operation of entomologists was being sought, not only in regard to the familiar though unexhausted field of pollination agencies, but also in regard to insect feeding-relations, and insect populations in relation to soil conditions, provision of shelter, dispersal of seed, etc. He hoped that this Flora might not only thus call for generous assistance from field entomologists, but would in its turn prove of value to them. He considered that we were only at the beginning of the application of scientific methods to the study of plant and animal populations in the field, although the promise of such application had been amply indicated by the papers which had just been communicated to the meeting.

Prof. P. A. Buxton directed attention to the interesting problem presented by the association of some native plant and closely related exotic species growing near it. He instanced *Iris pseudacorus*, the common yellow flag, and the fact that the sawfly so familiar on it spreads to some cultivated *Iris* spp. but not by any means to all, even if growing close to heavily attacked *I. pseudacorus*.

Mr. B. D. Wragge Morley thought that with reference to the attacks of insects on species of plants closely related to their indigenous host-plant and introduced from abroad, the following observations made in connection with work on the Bean and Beet aphis (*Aphis fabae* Scop.) might be of interest. The usual winter hosts of this aphis were *Euonymus europaeus* L. (The Common Spindle Tree) and *Viburnum Opulus* L. (The Guelder Rose). Observations had been made on foreign species of *Euonymus* at the Royal Botanic Gardens, Kew, the Botanic Gardens at Cambridge and in nurseries, and it had been found that all the species of the *europaeus* type (having the 4-lobed Rose Opal (RHS) coloured apterous fruit, with orange aril and white seed; leaves in shape and texture similar to *europaeus*; and stem slightly winged) were attacked, although many of these species came from the Far East. On the other hand, species of *latifolius* type (having winged Rose Opal (RHS) coloured fruit, elongate reddish winter buds and broad finely serrate oval leaves which turned a deep red in the autumn, and apterous stems) were only lightly colonised in the autumn. Their leaves were still present when the aphides returned, although they did in fact have an earlier leaf-fall. It was of interest in the case of *Viburnum Opulus* L. and *Viburnum Opulus sterile* De Candolle, both of which often grow in gardens, that when grown side by side or close to one another the *Opulus sterile* was always attacked more heavily than the *Opulus sens. strict.* In this case there was little visible morphological differentiation, but the *V. Opulus sens. strict.* had an earlier leaf-fall. It was suggested that physiological changes brought about by approaching leaf-fall might prove to be one of the factors affecting the choice of host-plant by the aphis.

Mr. A. J. Wilmott said that he thought it important to realise that the reasons why a particular insect fed on one or more species might be very varied; even if the last speaker's explanation concerning *Aphis fabae* giving leaf-fall as the decisive factor were correct, many other factors must be operative. Choice of food was likely to be guided, as in man, by both likes and dislikes. The choice of allied species, even if only in allied genera, might well be connected with some similarity in the organic compounds produced by the related species, which might be connected with the chemistry of the physiology of the insect, some species being digestible and others not. As food-plants for some insects [galls], Salicaceae and Rosales appeared to be connected, and this had been taken to show possible phylogenetic connections of the peculiar Salicaceae. He instanced a case of a series of British Buttercups which had been set aside for a long time: there were several sheets of *Ranunculus acer*, a species generally avoided by animals as containing an acrid principle, all of which except one were untouched by *Sitodrepa paniceum*, but one whole plant had been reduced completely to dust, presumably because it lacked the acrid principle. The range of food-plants could also vary, as was shown by the plant-parasite *Cuscuta epithymum*, which was common on Gorse and Heather, but which in a field near Wye in Kent was found on nearly thirty hosts: it was possible that this sort of thing might occur between insects and their food-plants. He thought it natural that the range of an insect should be less than its food-plant; it could not exceed it and the presence of the food-plant was but one of the factors controlling the distribution. One had to beware of generalising on insufficient data.

Professor Hale Carpenter asked how it was that Bark Beetles, normally attacking only unhealthy or dying trees, were able to become a pest to healthy trees. He said that perhaps an analogy could be found in medicine. The Protozoal cause of Human Trypanosomiasis in Africa normally lived in man with production of very little, if any, illness. It was spread through the agency of Tse-tse fly (*Glossina*) by means of a sexual cycle in that insect, provided that contact between fly and man was only occasional. But in the event of conditions favouring "broad" contact between man and fly, and frequent direct transmission of the Trypanosome from man to man by the fly, without the sexual cycle, the virulence of the Trypanosome was greatly increased and an "epidemic" resulted. What was it, he asked, that, in the case of Bark Beetles, normally prevented unduly rapid multiplication? What was the beginning of the affair? Did trees normally prevent the spread of bark beetles by some deterrent which the beetles by insistent attack in great numbers were able to overcome? Did trees cease to produce a deterrent, or did the beetles become by degrees less affected by constant exposure to it?

Dr. C. F. C. Beeson replied that the trees certainly did react to these attacks, but not to such an extent as to be able to control large-scale attacks.

Dr. W. H. THORPE referred to the probable influence of parasites in reducing or eliminating a polyphagous host species on certain of its food-plants. In this connection he drew attention to the desirability of placing on record, with as much detail as possible, particulars of differences in percentage parasitism associated with different food-plants. It was known for instance that certain species of hymenopterous parasite—e.g. *Pimpla ruficollis* Grav. on the Pine Shoot Moth, *Rhyacionia buoliana* Schiff. (Thorpe & Caudle, 1938, *Parasitology* **30**)—were attracted first to a particular food-plant or other restricted environment[2] and then parasitised, with varying degrees of discrimination, larvae which might be found on that plant. But the instances so far recorded were too few to enable us to say with any certainty whether this behaviour was the general rule or whether it was exceptional. The incidence of parasitism might of course depend on many other biological factors in the environment besides host food-plant. *P. ruficollis*, for instance, during the first part of its adult life, fed on the flowers of certain Umbelliferae, and the presence or absence of such plants might be an important factor influencing local distribution. Another factor likely to be overlooked was the availability of the required alternative hosts. As a probable example of this the striking variation in parasitism of two colonies of *Hyponomeuta padellus* L. on *Prunus spinosa* on the Sussex coast was mentioned (Thorpe, 1930, *Proc. ent. Soc. Lond.* **5**). The first colony infested a small area of stunted blackthorn bushes growing on the shingle of Dungeness Beach near " Jury's Gap ", there being no other blackthorn or hawthorn bushes within at least a mile. The parasitism of this colony was far below 1%, one species only, the polyembryonic Encyrtid, *Ageniaspis fuscicollis* Dalm., being found. A few miles away, along the ancient coastline escarpment between Pett and Winchelsea, were blackthorn and hawthorn bushes growing under more normal conditions and in an environment biologically incomparably more complex. Here the total parasitism was well over 45%, nine species of Hymenoptera (7 primaries, 2 secondaries) being involved. The more important of these parasites appeared to be dependent for the completion of their life-cycle on the presence of various other lepidopterous larvae as alternative hosts—species which were almost certainly lacking in the shingle beach environment.

Professor CHAMPION further stressed the point made by Dr. Beeson that the influence of insect attack on the specific composition of vegetation was relatively greater in the earlier stages of plant colonisation or succession, when the competition between species was most severe, and it might take very little to tilt the balance one way or the other. Thus a species susceptible to attacks by a shoot borer, as were various Meliaceae in the tropics, might be somewhat checked in height growth, and this might result in its being topped by competitors immune from this form of attack, and perhaps prevented from gaining a place in the dominant canopy. Many plant species seemed to develop poorly in their young stages, unless they grew in fairly compact groups, and insect attack, by thinning out regeneration beyond the density required for this, might again keep them out of the dominant canopy. It was the general belief (though apparently lacking in statistical support) that in species that seeded well only periodically, the percentage of seed destroyed by insects was significantly higher in poor seed years than in good seed years, and so the dependence of the species on the latter for maintaining its place in the vegetation was increased. Many saw in periodic seeding a protective adaptation against seed-eating insect enemies with a shorter, usually annual, life-cycle.

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[2] For similar examples among parasites of carrion-feeding Diptera and for a summary of the earlier literature see Laing, 1937, *J. animal Ecol.* **6**.

Dr. B. Barnes commented first on some points mentioned by previous contributors to the discussion. He doubted if there was any real difference between the mass flowering of bamboos at the end of a long period of vegetative growth and that of common weeds such as shepherd's purse (*Capsella Bursa-pastoris*) when those plants had completed their normal vegetative development; it was merely that the long vegetative period in the bamboos gave a fictitious appearance of something unusual and important. He remarked that just as related species of insects attacked members of the Rosaceae and Salicaceae, so did related species of fungi; he agreed that biochemical investigation was needed here. He went on to speak of the problems which arose when the relations between insects and plants were studied, and discussed two examples drawn from observations on feeding habits. In some years, *Malacosoma neustria* and *M. castrensis* abounded on the Essex coast, but, although *M. castrensis* flew well inland, it did not seem to lay eggs on apple. Yet, in captivity, its caterpillars could be raised successfully from egg to pupa on the leaves of apple, and, moreover, well-grown larvae brought in from the salt marsh on *Artemisia maritima* passed without hesitation to apple and finished their development on that plant. In 1936, he had large flowering clumps of three species of *Dianthus* from Central France, all started from seed in 1932. The capsules of *Dianthus monspessulanus* were heavily attacked by larvae of what was probably a species of *Dianthoecia*, but not those of *D. Carthusianorum* and *D. deltoides*. It was very unlikely that anyone else in the neighbourhood had *Dianthus monspessulanus* in cultivation and it was puzzling why this species only was attacked, and where the moth which had laid the eggs had come from; it could hardly have been a species which attacked *Dianthus* indiscriminately. Finally, he remarked that a great increase in the population of a given species could prove disadvantageous to that species by favouring the increase of a parasite. He once raised a large population of *Cerura vinula* which, in the fourth year of the experiment, was completely wiped out by the almost explosive development of an unidentified hymenopterous parasite, none of which had been seen until the third year of the experiment, and then only in very small numbers.

Dr. G. C. Varley suggested that it was possible to put on a common basis many of the varied specific problems raised by previous speakers. The place of a plant or animal species in any eco-system was dependent on its quantitative status, on whether it was common or not. This was ideally definable either in terms of population density, or weight per unit area. Problems of numbers, or of animal or plant distribution, were insoluble until the fundamental problem of what factors controlled the population density of the species of plant or animal in the community had been solved. The reaction of each species to the physical environment, and its interaction with other species, had to be known. It was his belief that when ecology went beyond the descriptive stage, and studied and analysed the problems numerically, a rapid advance would follow.

Dr. B. P. Uvarov said that to him it was very significant that practically all previous speakers had concentrated their attention on problems of the individual ecology of species, or of groups of species, rather than on the community ecology. This latter aspect of ecological studies was particularly well developed in the United States, where ecology meant mainly the preparation of long lists of species occurring in a type of habitat and assumed to form a community of plants and animals. The technique of such studies had become greatly developed and standardised; a complicated classification of community members into dominants, sub-dominants, influents, sub-influents, etc., had been elaborated; and anyone with sufficient time and energy could draw up lists of communities, compare and combine them and make statistically derived conclusions without troubling to investigate the real ecological requirements of each species and its interrelations with others. The amount of such " synecological " studies was becoming appallingly large, but it was a striking fact that they had produced, so far, very few conclusions of general value. One of the favourite groups for such studies was grasshoppers (ACRIDIDAE) and as a specialist in this group, he could positively say that the vast number of papers, mostly American, dealing with grasshopper communities, had not led to any generalisations about the factors of ecological distribution and similar problems of broad interest. On the other hand, even a few studies on the ecology of single Acridid species had resulted in a wealth of ideas and theories of far-reaching importance. It appeared that a close and thorough study of a single species in all its interrelations with its physical and biotic environment was infinitely more promising than a semi-mechanical compilation of long community lists, in which species figured merely as names. It was for this reason that the tendency of British ecologists to study single species should be regarded as a most hopeful sign. Such studies involved a great amount of exact observation, including the collection of quantitative data, but they did lead to a real understanding of the factors regulating the life of a species in a given environment. The examples of hover-flies quoted by Captain Diver were sufficient to show how unexpected and subtle might be the factors limiting the occurrence of a species. The way of individual ecological studies might be a long and arduous one, but it was a very healthy symptom that British ecologists were deliberately choosing it instead of the easier, but barren, method of mass collecting, counting and statistical analysis of populations assumed to form communities.

N. D. RILEY, *Hon. Secretary.*

PROCEEDINGS OF THE GENERAL MEETING HELD ON 1ST DECEMBER, 1943.

Dr. E. A. COCKAYNE, M.D., F.R.C.P., President, in the Chair.

Present, 40 Fellows and 4 Visitors.

The minutes of the meeting held on 3rd November were confirmed and signed by the President.

The President announced the death of Sir Edward Bagnall Poulton, F.R.S., who was elected a Fellow of the Society in 1884, and became Honorary Life President in 1934. The funeral at Oxford was attended by Dr. Cockayne (President), Professor Hale Carpenter, Professor Champion, and several other Fellows of the Society.

The President also reported the death of H. Willoughby Ellis, elected in 1900, who had been Vice-President on four occasions, and of H. H. May, elected in 1916.

The Secretary read for the second time the nominations for Officers and Council for 1944.

The Secretary read the names of the following new candidates for election: P. B. M. Allan, M.A., D. W. Mollison, D. A. Quirke, C. R. Cunningham van-Someren and G. H. Thompson.

The Secretary announced that the following had been elected Fellows of the Society: H. K. Airy Shaw, B.A., F.L.S., The Herbarium, Royal Botanic Gardens, Kew, Surrey; R. J. Cousins, Lane End, Westmill, Buntingford, Herts; Mrs. Violet G. Jeffery, 195, Walmersley Road, Bury, Lancs; A. J. Musgrave, 21, Loveday Road, London, W. 13; A. R. Palmer, Oving, The Avenue, Flitwick, Beds; B. Vesey-FitzGerald, F.L.S., Red Rise, Burley, near Ringwood, Hants.

Thanks were voted to donors of gifts to the Library since the last meeting.

Dr. J. R. Busvine signed the Obligation Book and was admitted a Fellow.

The following paper was read in title: "The structure and mechanism of the spiracular regulatory apparatus in adult Diptera and certain other groups of insects," by A. A. G. Hassan, communicated by Dr. W. H. Thorpe.

Communications were made by Dr. J. R. Busvine and Dr. K. Jordan, F.R.S., abstracts of which appeared on p. 34.

N. D. RILEY, *Hon. Secretary.*

The next Meeting will be held on 2nd February, 1944, **at 3.30 p.m.**

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